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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/587,895	07/28/2006	Shu Kobayashi	062844	2335

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EXAMINER	
ROBINSON, RENEE E	

ART UNIT	PAPER NUMBER
4132	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/587,895	KOBAYASHI ET AL.	
	Examiner	Art Unit	
	RENEE ROBINSON	4132	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3-8 and 10-17* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,3-8 and 10-17* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *28 July 2006* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *20060728, 20070105*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Objections

1. Claim 13 is objected to because of the following informalities: the limitation "tungsten, osmium, iridium, and palladium" in line 5 is repeated in line 6 and appears to be a typing error. Appropriate correction is required.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claims 1, 3-8, and 10-17 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

4. Claim 1 recites the limitation "the channel" in line 5. There is insufficient antecedent basis for this limitation in the claim, since there is no mention of a channel in the previous content of claim 1.

5. Regarding claims 1 and 8, it is unclear what is meant by the limitation "or in a spacer via a group of the polymer surface" in lines 8-11. It is unclear what in this step necessarily results in the polymer-incorporated catalyst being supported on the inner wall of the channel.

6. Claim 8 recites the limitation "the channel" in line 5. There is insufficient antecedent basis for this limitation in the claim, since there is no mention of a channel in the previous content of claim 8.

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

9. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

10. Claims 1-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Remy (U.S. Pub. No. 2005/0170142) in view of Harston et al (WO 99/22857) and in view of Akiyama et al ("The Polymer Incarcerated Method for the Preparation of Highly Active Heterogeneous Palladium Catalysts").

11. Regarding claim 1, Remy discloses a method of catalytic reaction using a microreactor (page 5, paragraph 0045), which comprises:

- using a microcreactor with a metal catalyst as a solid phase supported on the inner wall of the channel (page 2, paragraph 0027), in which the catalyst is supported on the inner wall of the microchannel by strong binding between the coatings and materials used to fabricate the microchannel walls (i.e. metal and silicon) (page 3, paragraph 0028);
- passing one or more reactants through an inlet port, allowing for the reactants to interact with the catalyst impregnated layer on the microchannel wall (page 5, paragraph 0045).

12. Remy further discloses that the microreactor is useful for gas-liquid reactions; therefore, the embodiment disclosed above encompasses passing both liquid and gas reactants through the microchannel (page 1, paragraph 0008). Therefore, the result is a solid-liquid-gas phase reaction accelerated by the solid metal catalyst. Remy explains that packed bed microreactors, or microreactors packed with a solid catalyst, have the adverse effect of a substantial pressure drop created within the microreactor (page 1, paragraph 0009). As such, coating the microchannel walls with the catalyst attempts to overcome this shortcoming (page 1, paragraph 0010). Remy discloses that strong bindng of the catalyst on the microchannel wall results in an active catalyst which is substantially uniformly distributed throughout the coating to achieve optimal effectiveness for the particular reactant stream and/or reactant combination being processed (page 3, paragraphs 0028-0029).

13. Remy does not expressly disclose:

- passing the gas at the center part of the channel;

- passing the liquid phase reactant between the gas and the catalyst supported on the inner wall of the channel.

14. Further, Remy does not expressly disclose that the metal or metal complex catalyst is incorporated in a polymer. Nor does Remy expressly disclose that the catalyst incorporated in a polymer is supported on the inner wall of the channel by covalent bonding of a group provided on the inner wall of the channel or in a spacer via a group on the polymer surface.

15. Harston discloses a method of catalytic reaction using a microreactor which comprises passing a gas at the center part of the channel and passing a solution as a liquid phase in which a reactant is dissolved (organic compounds) between the gas and catalyst supported on the inner wall of the channel (page 6, lines 5-6 and Fig. 2).

16. Akiyama teaches a method for incorporating palladium catalysts in a polymer, which creates recoverable, reusable, and highly active heterogeneous palladium catalysts for hydrogenation, carbon-carbon, and carbon-oxygen bond forming reactions (page 3412, paragraph 1). Akiyama further teaches that immobilization of palladium catalysts onto inorganic supports is possible, but can cause a serious problem of leaching of the catalysts during and/or after reactions (page 3412, paragraph 1).

17. It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the process as disclosed by Remy by passing the gas down the center of the microchannel and passing the liquid between the gas and the catalytic walls of the microchannel. One having ordinary skill in the art would have been motivated to do this because Harston teaches that operating a catalytic reaction in a microreactor in this way is effective in accelerating a reaction between liquid and gas reactants.

18. It further would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the process as disclosed by Remy such that the catalyst supported on the microchannel wall is a catalyst incorporated in a polymer. One having ordinary skill in the art would have been motivated to do this because Remy emphasizes the importance of immobilizing a catalyst on the microreactor wall instead of packing the catalyst in the channel and Akiyama teaches that using a polymer to immobilize the catalyst is an effective way to maintain the catalytic activity and prevent leaching of an immobilized catalyst.

19. Regarding claim 3, Remy teaches using a catalyst from group VIIIA of the Periodic Table, which encompasses using Palladium as the catalyst (page 5, paragraph 0046).

20. Regarding claim 4, Remy teaches using a catalyst from groups IVA, VA, VIA, VIIA and VIIIA of The Periodic Table, which encompasses the claimed catalysts (page 5, paragraph 0046).

21. Regarding claims 5 and 6, Remy discloses using a catalyst which includes at least the precious metal catalyst of group VIIIA, as well as transition metals from groups IVA, VA, VIA, VIIA and VIIIA thereof of The Periodic Table (page 5, paragraph 0046). Therefore, the combination of metals in the catalyst constitutes a metal complex catalyst. Further, the disclosed metal groups encompass the claimed metal complexes.

22. Regarding claim 7, Remy discloses that the microreactor is useful for gas-liquid reactions, but fails to expressly disclose that the gas phase consists of hydrogen or carbon monoxide.

23. Harston discloses carrying out hydrogenation reactions in the microreactor, in which an organic liquid is contacted with a flow of hydrogen gas (page 6, lines 24-26).

24. It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the catalytic reaction method as disclosed by Remy by passing hydrogen through the microreactor as the gas phase. One having ordinary skill in the art would have been motivated to do this because Harston teaches that passing hydrogen through the microreactor is effective in catalytic hydrogenation reactions.

25. Regarding claim 8, Remy discloses a method of catalytic reaction using a microreactor (page 5, paragraph 0045), which comprises:

- using a microcreactor with a metal catalyst as a solid phase supported on the inner wall of the channel (page 2, paragraph 0027), in which the catalyst is supported on the inner wall of the microchannel by strong binding between the coatings and materials used to fabricate the microchannel walls (i.e. metal and silicon) (page 3, paragraph 0028);
- passing one or more reactants through an inlet port, allowing for the reactants to interact with the catalyst impregnated layer on the microchannel wall (page 5, paragraph 0045).

26. Remy further discloses that the microreactor is useful for gas-liquid reactions; therefore, the embodiment disclosed above encompasses passing both liquid and gas reactants through the microchannel (page 1, paragraph 0008). Therefore, the result is a solid-liquid-gas phase reaction accelerated by the solid metal catalyst. Remy explains that packed bed microreactors, or microreactors packed with a solid catalyst, have the adverse effect of a substantial pressure drop created within the microreactor (page 1, paragraph 0009). As such, coating the microchannel walls with the catalyst attempts to overcome this shortcoming (page 1, paragraph 0010). Remy discloses that strong bindng of the catalyst on the microchannel wall results in an active catalyst which is substantially uniformly distributed throughout the coating to achieve optimal

effectiveness for the particular reactant stream and/or reactant combination being processed (page 3, paragraphs 0028-0029).

27. Remy does not expressly disclose:

- passing the gas at the center part of the channel;
- passing the liquid phase reactant between the gas and the catalyst supported on the inner wall of the channel.

28. Further, Remy does not expressly disclose that the gas is hydrogen or that the metal or metal complex catalyst is incorporated in a polymer. Nor does Remy expressly disclose that the catalyst incorporated in a polymer is supported on the inner wall of the channel by covalent bonding of a group provided on the inner wall of the channel or in a spacer via a group on the polymer surface.

29. Harston discloses a method of catalytic reaction using a microreactor which comprises passing a gas at the center part of the channel and passing a solution as a liquid phase in which a reactant is dissolved (organic compounds) between the gas and catalyst supported on the inner wall of the channel (page 6, lines 5-6 and Fig. 2). Harston further discloses carrying out hydrogenation reactions in the microreactor, in which an organic liquid is contacted with a flow of hydrogen gas (page 6, lines 24-26).

30. Akiyama teaches a method for incorporating palladium catalysts in a polymer, which creates recoverable, reusable, and highly active heterogeneous palladium catalysts for hydrogenation, carbon-carbon, and carbon-oxygen bond forming reactions (page 3412, paragraph 1). Akiyama further teaches that immobilization of palladium catalysts onto inorganic

supports is possible, but can cause a serious problem of leaching of the catalysts during and/or after reactions (page 3412, paragraph 1).

31. It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the process as disclosed by Remy by passing hydrogen gas down the center of the microchannel and passing the liquid between the hydrogen gas and the catalytic walls of the microchannel. One having ordinary skill in the art would have been motivated to do this because Harston teaches that operating a catalytic reaction in a microreactor in this way is effective in accelerating a reaction between liquid and hydrogen gas reactants, such as in hydrogenation reactions.

32. It further would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the process as disclosed by Remy such that the catalyst supported on the microchannel wall is a catalyst incorporated in a polymer. One having ordinary skill in the art would have been motivated to do this because Remy emphasizes the importance of immobilizing a catalyst on the microreactor wall instead of packing the catalyst in the channel and Akiyama teaches that using a polymer to immobilize the catalyst is an effective way to maintain the catalytic activity and prevent leaching of an immobilized catalyst.

33. Regarding claim 10, Remy teaches using a catalyst from group VIIIA of the Periodic Table, which encompasses using Palladium as the catalyst (page 5, paragraph 0046).

34. Regarding claim 11, Remy teaches using a catalyst from groups IVA, VA, VIA, VIIA and VIIIA of The Periodic Table, which encompasses the claimed catalysts (page 5, paragraph 0046).

35. Regarding claims 12 and 13, Remy discloses using a catalyst which includes at least the precious metal catalyst of group VIIIA, as well as transition metals from groups IVA, VA, VIA, VIIA and VIIIA thereof of The Periodic Table (page 5, paragraph 0046). Therefore, the combination of metals in the catalyst constitutes a metal complex catalyst. Further, the disclosed metal groups encompass the claimed metal complexes.

36. Claims 14-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Remy (U.S. Pub. No. 2005/0170142) in view of Harston et al (WO 99/22857) and in view of Akiyama et al ("The Polymer Incarcerated Method for the Preparation of Highly Active Heterogeneous Palladium Catalysts"), and further in view of Kobayashi et al ("A Microfluidic Device for Conducting Gas-Liquid-Solid Hydrogenation Reactions").

37. Remy in view of Harston and in view of Akiyama is relied upon as set forth above in the rejection of claims 1 and 8.

38. Regarding claims 14 and 16, Remy in view of Akiyama and in view of Harston does not expressly disclose that the surface of the inner wall of the channel has silanol groups and that the spacer is covalently bonded with the silanol group by Si—O—Si bonds.

39. Kobayashi teaches immobilizing an active Pd catalyst on the wall of a microreactor channel by incorporating the catalyst in a polymer and binding the polymer incorporated catalyst to the microchannel wall (page 1306, paragraph 2). The inner wall of the microchannel has silanol groups which forms covalent Si—O—Si bonds with a spacer (Fig. 2).

40. Regarding claims 15 and 17, Akiyama teaches that the polymer surface contains epoxide groups (Fig. 1). However, Remy in view of Akiyama and in view of Harston does not expressly

disclose a spacer which is modified with a functional group that is bondable with an epoxide group.

41. Kobayashi further teaches that the polymer surface contains epoxide groups which are bondable with a functional group on the spacer (Fig. 2). Kobayashi explains that this embodiment of the immobilized catalyst increased the interfacial area between the liquid and the gas and the solid, providing an efficient environment for hydrogenation (page 1307, paragraph 1).

42. It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the catalytic reaction method as disclosed by Remy in view of Harston and in view of Akiyama by modifying the microchannel wall to include silanol groups so as to form covalent bonds with a spacer. It further would have been obvious to modify the spacer such that it is bondable with epoxide groups on the polymer incorporated catalyst. One having ordinary skill in the art would have been motivated to do this because Kobayashi teaches that it is effective in immobilizing the polymer-incorporated catalyst on the wall of the microchannel, thereby improving conditions for catalytic reactions carried out in the microreactor.

Conclusion

43. Any inquiry concerning this communication or earlier communications from the examiner should be directed to RENEE ROBINSON whose telephone number is (571)270-7371. The examiner can normally be reached on Monday through Thursday 7:30-5:00.

44. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Lavilla can be reached on (571)272-1539. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

45. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/RENEE ROBINSON/
Examiner, Art Unit 4132
5 November 2008

/Alicia Chevalier/
Primary Examiner, Art Unit 1794